FORM PTO-1390 (REV 10-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	P/4074-4
	U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 10/009409

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/04888	29 May 2000	10 June 1999

TITLE OF INVENTION: INTRAOCULAR LENS

APPLICANT(S) FOR DO/EO/US: Wilhelm STORK and Christine F. KREINER

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. [X] The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [ ] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [X] Other items or information:
    14 pages of appln. in German
    1 Drawing Sheet (Figs. 1-2)
    Inventors Designation Sheet
    Print EFS Form
    Intl. Search Report
    Intl. Prelim. Exam. Report

EXPRESS MAIL CERTIFICATE

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail Post Office to Addresses (mail label EL924390985US in an envelope addressed to: U.S. Patent and Trademark Office, P.O. Box 2327, Arlington, VA 22202 on December 10, 2001

Dorothy Jenkins
Name of Person Mailing Correspondence

Dorothy Jenkins
Signature

December 10, 2001
Date of Signature

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/009409	PCT/EP00/04888	P/4074-4

17. [X] The following fees are submitted:	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):	
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1,040.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO 890.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO 740.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) 710.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890.00
Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	16 - 20 =	0	X $18.00	$
Independent claims	1 - 3 =	0	X 84.00	$
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ 280.00	$
TOTAL OF ABOVE CALCULATIONS =				$ 890.00
[X] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$ 445.00
SUBTOTAL =				$ 445.00
Processing fee of $130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$
TOTAL NATIONAL FEE =				$ 445.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$
TOTAL FEES ENCLOSED =				$ 445.00
			Amount to be refunded:	$
			charged:	$

a. [X] A check in the amount of $ 445.00 to cover the above fees is enclosed. Check No. 7670

b. [ ] Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 15-0700. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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24,735

REGISTRATION NUMBER

P/4074-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

Wilhelm STORK et al

Serial No.: 10/009,409

Filed: December 10, 2001

Int'l. Appl. No.: PCT/EP00/04888

Int'l. Filing Date: May 29, 2000

For: INTRAOCULAR LENS

Date: March 27, 2002

Group Art Unit: not yet known

Examiner: not yet known

U.S. Patent & Trademark Office
P.O. Box 2327
Arlington, VA 22202

PRELIMINARY AMENDMENT

Prior to examination, please amend the application as follows.

FEE CALCULATION

Any additional fee required has been calculated as follows:

_____ If checked, "Small Entity" status is claimed.

	NO. CLAIMS AFTER AMENDMENT		HIGHEST NO. PREVIOUSLY PAID FOR		EXTRA PRESENT		RATE	ADDIT. FEE
TOTAL	17	MINUS	20	* =	0	X	($9 SE or $18)	$0
INDEP.	1	MINUS	3	** =	0	X	($42 SE or $84)	$0
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM						X	($140 SE or $280)	$0
* not less than 20 ** not less than 3							TOTAL	$0

In the event the actual fee is greater than the payment submitted or is inadvertently not enclosed or if any additional fee during the prosecution of this application is not paid, the Patent Office is authorized to charge the underpayment to Deposit Account No. 15-0700.

CONTINGENT EXTENSION REQUEST

If this communication is filed after the shortened statutory time period had elapsed and no separate Petition is enclosed, the Commissioner of Patents and Trademarks is petitioned, under 37 C.F.R. § 1.136(a), to extend the time for filing a response to the outstanding Office Action by the number of months which will avoid abandonment under 37 C.F.R. § 1.135. The fee under 37 C.F.R. § 1.17 should be charged to our Deposit Account No. 15-0700.

AMENDMENTS

__X__ If checked, amendments to the specification and/or claims are submitted herewith.

1. __X__ If checked, an abstract is submitted as the last page of Appendix A.

2. Specification:

Please delete the paragraph(s)/section(s) beginning at paragraph at page 2, line 1 to page 2, line 2; paragraph at page 2, line 19 to page 2, line 20; paragraphs at page 4, line 18 to page 5, line 12; paragraph at page 9, line 1 to page 9, line 9; and replace such paragraph(s)/section(s) pursuant to 37 C.F.R. § 1.121(b)(ii) with the "clean" version attached hereto as Appendix A. Entry is respectfully requested. A version with markings to show the changes made pursuant to 37 C.F.R. § 1.121(b)(iii) is attached hereto as Appendix B.

3. Claims:

Please amend claims 1-16 and add new claim 17 pursuant to 37 C.F.R. § 1.121(c)(i) as set forth in the "clean" version attached hereto as Appendix A. Entry is respectfully requested. A version with markings to show the changes made pursuant to 37 C.F.R. § 1.121(c)(ii) is attached hereto as Appendix B.

REMARKS/ARGUMENT

The original claims have been amended for U.S. practice. The original claims have not been narrowed by this Amendment, but rather have been restated in U.S. form.

Minor specification amendments are made.

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail Post Office to Addressee (mail label #EL 924373077 US) in an envelope addressed to: Asst. Commissioner for Patents, Washington, D.C. 20231, on March 27, 2002:

Dorothy Jenkins

Name of applicant, assignee or Registered Representative

Dorothy Jenkins

Signature

March 27, 2002

Date of Signature

RCF:dmk/sds/ahc

Respectfully submitted,

Robert C. Faber

Registration No.: 24,322

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APPENDIX A

"CLEAN" VERSION OF EACH PARAGRAPH/SECTION/CLAIM
37 C.F.R. § 1.121(b)(ii) AND (c)(i)

SPECIFICATION:

Paragraph at page 2, line 1 to page 2, line 2:

BACKGROUND OF THE INVENTION

The invention relates to an intraocular lens having a central lens area and a surrounding annular lens area.

Paragraph at page 2, line 19 to page 2, line 20:

This object is achieved according to the invention by an intraocular lens with an optical lens part, which has a central lens area and at least one further annular lens area surrounding said central lens area, the central lens area and the at least one annular lens area forming at least one common focus and the annular lens area having concentric annular zones, in which the difference in pathlength between adjacent zones is an integral multiple of n=2 or more of the design wavelength.

Paragraphs at page 4, line 18 to page 5, line 12:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a sectional representation through one half of a lens body of an intraocular lens, and

Figure 2 shows a graphic representation to explain an additional diffractive fine structure, for the forming of a bifocal intraocular lens.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The optical lens part 1, represented in the figures, of an intraocular lens has a central, in

particular refractive, lens area 2 and a lens are 3 arranged in an annular form around the central lens area 2. The annular lens area 3 is located in an edge zone of the lens body. In the case of the exemplary embodiment represented, fine structure elements, in particular with a sawtooth shape, are arranged both on the front side and on the rear side of the lens body in concentric zones around the optical axis 6 of the lens part 1. It is also possible, however, to provide the sawtooth-like zones only on one side of the lens (front side or rear side).

Paragraph at page 9, line 1 to page 9, line 9:

CLAIMS (with indication of amended or new):

Amended 1. An intraocular lens comprising

an optical lens part which has a central lens area and at least one further annular lens area surrounding the central lens area, wherein the central lens area and the at least one annular lens area form at least one common focus; the annular lens area having concentric annular zones each with a respective optical path of a respective path length, wherein the difference in path length of the optical path between adjacent concentric zones is an integral multiple of n = 2 or more of a design wavelength.

Amended 2. The intraocular lens as claimed in claim 1, wherein the difference in path length is set by at least one of a selected refractive index of a material or a geometry of the respective zone.

Amended 3. The intraocular lens as claimed in claim 1, wherein the annular zones are formed in a sawtooth-like manner.

Amended 4. The intraocular lens as claimed in claim 1, wherein the lens has a lens body with opposite front and rear sides and the annular zones are provided on at least one of the front and rear sides of the lens body.

Amended 5. The intraocular lens as claimed in claim 1, wherein a refractive component is formed in the central lens area.

Amended 6. The intraocular lens as claimed in claim 1, wherein the optical lens part has a further meridian section an aspherical curvature profile.

Amended 7. The intraocular lens as claimed in claim 6, wherein the annular area with the concentric zones has the different path lengths arranged in the lens part in which the aspherical curvature profile has an effect.

Amended 8. The intraocular lens as claimed in claim 1, wherein the annular lens area has a width of approximately 0.8 mm to 0.9 mm.

New 9. The intraocular lens as claimed in claim 1, wherein the central lens area has a diameter of approximately 4 mm.

Amended 10. The intraocular lens as claimed in claim 1, wherein the lens has an outer lens edge with an approximately semicircular cross section.

Amended 11. The intraocular lens as claimed in claim 1, wherein the central lens area has a smooth surface.

Amended 12. The intraocular lens as claimed in claim 1, wherein the lens is a bifocal lens having additional diffractive zones on the optical lens part.

Amended 13. The intraocular lens as claimed in claim 12, wherein the additional diffractive zones are provided on the central lens area, forming the refractive component.

Amended 14. The intraocular lens as claimed in claim 12, wherein the additional

diffractive zones are shaped so that the difference in path length between the adjacent diffractive zones is a fraction of a design wavelength.

Amended 15. The intraocular lens as claimed in claim 14, wherein the difference in path length between the adjacent diffractive zones is 0.4 or 0.6 of the design wavelength.

Amended 16. The intraocular lens as claimed in claim 15, wherein the design wavelength lies in the green spectral range of visible light.

New. 17. The intraocular lens as claimed in claim 1, wherein the annular lens area has a width of approximately 0.8 mm to 0.9 mm, in particular 0.835 mm.

ABSTRACT:

An intraocular lens with an optical lens part, which has a central lens area and at least one further annular lens area surrounding the central lens area, the central lens area and the at least one annular lens area forming at least one common focus and the annular lens area having concentric annular zones, in which the difference in pathlength between adjacent zones is an integral multiple of n=2 or more of the design wavelength.

APPENDIX B

VERSION WITH MARKINGS TO SHOW CHANGES MADE
37 C.F.R. § 1.121(b)(iii) AND (c)(ii)

SPECIFICATION:

Paragraph at page 2, line 1 to page 2, line 2:

BACKGROUND OF THE INVENTION

The invention relates to an intraocular lens having a central lens area and a surrounding annular lens area [according to the preamble of patent claim 1].

Paragraph at page 2, line 19 to page 2, line 20:

This object is achieved according to the invention by an intraocular lens with an optical lens part, which has a central lens area and at least one further annular lens area surrounding said central lens area, the central lens area and the at least one annular lens area forming at least one common focus and the annular lens area having concentric annular zones, in which the difference in pathlength between adjacent zones is an integral multiple of n=2 or more of the design wavelength [the defining features of patent claim 1].

Paragraphs at page 4, line 18 to page 5, line 12:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 [figure 1] shows a sectional representation through one half of a lens body of an intraocular lens, and

Figure 2 [figure 2] shows a graphic representation to explain an additional diffractive fine structure, for the forming of a bifocal intraocular lens.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The optical lens part 1, represented in the figures, of an intraocular lens has a central, in

particular refractive, lens area 2 and a lens are 3 arranged in an annular form around the central lens area 2. The annular lens area 3 is located in an edge zone of the lens body. In the case of the exemplary embodiment represented, fine structure elements, in particular with a sawtooth shape, are arranged both on the front side and on the rear side of the lens body in concentric zones around the optical axis 6 of the lens part 1. It is also possible, however, to provide the sawtooth-like zones only on one side of the lens (front side or rear side).

Paragraph at page 9, line 1 to page 9, line 9:

[1 optical lens part

2 central lens area

3 annular lens area

4 peripheral edge

5 straight piece

6 optical axis

7 additional diffractive fine structure elements

8 refractive base curve]

CLAIMS:

Amended 1. An intraocular lens comprising [with]

an optical lens part [,] which has a central lens area and at least one further annular lens area surrounding the [said] central lens area, [characterized in that] wherein the central lens area [(2)] and the at least one annular lens area [(3)] form at least one common focus; [, and in that] the annular lens area [(3)] having [has] concentric annular zones each with a respective optical path of a respective path length, wherein [, in which] the difference in path length of the optical path between adjacent concentric zones is an integral multiple of n = 2 or more of [the] a design wavelength.

Amended 2. The intraocular lens as claimed in claim 1, wherein [characterized in that]

the difference in path length is set by at least one of a selected [the] refractive index of a [or the] material or a [and/or the] geometry of the respective zone.

Amended 3. The intraocular lens as claimed in claim 1, wherein [or 2, characterized in that] the annular zones are formed in a sawtooth-like manner.

Amended 4. The intraocular lens as claimed in claim 1, wherein the lens has a lens body with opposite front and rear sides and the annular zones are provided on at least one of the front and [one of claim 1 to 3, characterized in that the annular zones are provided on the front side and/or] rear sides [side] of the lens body [(1)].

Amended 5. The intraocular lens as claimed in claim 1 wherein [one of claims 1 to 4, characterized in that] a refractive component [(2)] is formed in the central lens area [(2)].

Amended 6. The intraocular lens as claimed in claim 1, wherein [one of claims 1 to 5, characterized in that] the optical lens part has a further meridian section an aspherical curvature profile.

Amended 7. The intraocular lens as claimed in claim 6, wherein [one of claims 1 to 6, characterized in that] the annular area [(3)] with the concentric zones has [having] the different path lengths arranged in the lens part in which the aspherical curvature profile has an effect.

Amended 8. The intraocular lens as claimed in claim 1, wherein [one of claims 1 to 7, characterized in that] the annular lens area [(3)] has a width of approximately 0.8 mm to 0.9 mm[, in particular 0.835 mm].

Amended 9. The intraocular lens as claimed in claim 1, wherein [one of claims 1 to 7, characterized in that] the central lens area [(2)] has a diameter of approximately 4 mm.

Amended 10. The intraocular lens as claimed in claim 1, wherein [one of claims 1 to 7, characterized in that] the lens has an outer lens edge with [(4) has] an approximately semicircular cross section.

Amended 11. The intraocular lens as claimed in claim 1, wherein [one of claims 1 to 7, characterized in that] the central lens area [(2)] has a smooth surface.

Amended 12. The intraocular lens as claimed in claim 1, wherein the lens is [one of claims 1 to 7, characterized in that, for forming] a bifocal lens[,] having additional diffractive zones [(7) are provided] on the optical lens part.

Amended 13. The intraocular lens as claimed in claim 12, wherein [characterized in that] the additional diffractive zones [(7)] are provided on the central [central] lens area, forming the refractive component [(2)].

Amended 14. The intraocular lens as claimed in claim 12, wherein the additional diffractive zones are shaped so [one of claims 1 to 13, characterized in] that the difference in path length between the adjacent diffractive zones [(7)] is a fraction of [the] a design wavelength.

Amended 15. The intraocular lens as claimed in claim 14, wherein [one of claims 1 to 14, characterized in that] the difference in path length between the adjacent diffractive zones [(7)] is 0.4 or 0.6 of the design wavelength.

Amended 16. The intraocular lens as claimed in claim 15, wherein [one of claims 1 to 15, characterized in that] the design wavelength lies in the green spectral range of visible light.

New. 17. The intraocular lens as claimed in claim 1, wherein the annular lens area has a width of approximately 0.8 mm to 0.9 mm, in particular 0.835 mm.

ABSTRACT:

An intraocular lens with an optical lens part, which has a central lens area [2] and at least one further annular lens area [3] surrounding [said] the central lens area, the central lens area [2] and the at least one annular lens area [3] forming at least one common focus and the annular lens area [3] having concentric annular zones, in which the difference in pathlength between adjacent zones is an integral multiple of n=2 or more of the design wavelength.

[(Figure 1)]

[Patent application]

[Title of the invention)

Intraocular lens

[Description]

The invention relates to an intraocular lens according to the preamble of patent claim 1.

[Prior Art]

An intraocular lens of this type is known from EP 0 537 643 B1. This lens may be designed as a monofocal lens, and consequently be made relatively thin, by the optical power being made up of a refractive component and a diffractive component. The cut to be made to the eye during the implantation can be kept small. Scatterings of light resulting from the diffractive fine structure component may influence the quality of the image produced on the retina.

[Object of the invention]

The object of the invention is to provide an intraocular lens of the type stated at the beginning in which an image with improved quality is produced on the retina with a low lens thickness.

[Examples]

This object is achieved according to the invention by the defining features of patent claim 1.

In the case of the intraocular lens according to the invention, arranged around a central lens area, which has

refractive properties in particular, is at least one annular lens area, which forms a common focus with the central lens area, concentric annular zones arranged around the optical lens axis being provided in the annular lens area, the difference in the path length or difference in optical path between adjacent zones being an integral multiple of the design wavelength.

In a preferred way, the design wavelength is provided in the green spectral range of visible light, in the range of 550 nm for example.

The difference in path length of the adjacent zones may be set by the refractive index or by appropriate material selection and/or the geometry of the respective zone.

In a preferred way, the curvature of the meridial section of the optical lens part is aspherically formed, the zones with the differences in path length (differences in optical path) being provided in the edge region, in which the deviation of the aspherical profile from the spherical curve has an effect.

These annular zones, which are arranged concentrically around the optical lens axis, are formed in particular in a sawtooth shape. For forming a monofocal intraocular lens, these zones have the same optical power as the central, in particular refractive, lens area. Both parts

contribute to a sharp image, which is produced on the retina of the eye.

For forming a bifocal lens, the optical lens part may be provided with an additional diffractive fine structure, which may extend over the entire optical lens part or, in a preferred way, is provided only on the central lens area, forming the refractive component. This is generally sufficient, since the bifocal function is required only when there is brightness corresponding to daylight and the pupillary aperture of the eye is essentially open only in the region of the central lens area, containing the refractive component. The additional diffractive fine structure, in particular in the form of concentric zones arranged around the optical lens axis, may be formed in such a way that adjacent zones produce a difference in path length of the optical path which is a fraction of the design wavelength, for example 0.4 or 0.6.

The invention is explained in more detail on the basis of exemplary embodiments with reference to the figures, in which:

figure 1 shows a sectional representation through one half of a lens body of an intraocular lens, and

figure 2 shows a graphic representation to explain an additional diffractive fine structure, for the forming of a bifocal intraocular lens.

The optical lens part 1, represented in the figures, of an intraocular lens has a central, in particular refractive, lens area 2 and a lens area 3 arranged in an annular form around the central lens area 2. The annular lens area 3 is located in an edge zone of the lens body. In the case of the exemplary embodiment represented, fine structure elements, in particular with a sawtooth shape, are arranged both on the front side and on the rear side of the lens body in concentric zones around the optical axis 6 of the lens part 1. It is also possible, however, to provide the sawtooth-like zones only on one side of the lens (front side or rear side).

Adjacent zones have a difference in path length of the respective optical path which corresponds to an integral multiple of two or more of the design wavelength. By different selection of the material in the respective adjacent annular zones and the associated different refractive indices and/or the geometry, in particular the sawtooth shape, this difference in path length of the respective optical paths can be achieved.

An outer peripheral edge 4 of the lens body has an approximately semicircular cross section, with a radius of 0.165 mm. The semicircular edge begins at a radial distance of approximately 2.835 mm from the optical axis 6. A planar straight piece 5 may be provided between the edge 4 and the

annular lens area 3 with the sawtooth-like zones. This is the case in particular whenever the outermost sawtooth zone can no longer be provided completely before the semicircular lens edge 4. The diameter of the lens is approximately 6 mm. In a preferred way, at least three annular sawtooth zones are provided in the annular lens area 3 in the vicinity of the lens edge 4.

The various curve portions are described by various functions in the respective portions.

The optical lens part is described by the following function:

$$Z_{asph}(r)=R-\sqrt{R^2-r^2}+a_4\cdot r^4+a_6\cdot r^6+a_8\cdot r^8+a_{10}\cdot r^{10}+\ldots. \text{ if } <r<r_{rfres\_begin}$$

The annular lens area 3 is described by the floor function:

$$z\_fres(r)= z_{asph}(r)-\text{floor}\left[\frac{Z_{asph}(r)-Z_{asph}(r_{fres\_begin})}{\text{tooth depth}}+1\right]\cdot\text{tooth depth}$$

if $r_{rdres\_begin}<r<r_{fres\_end}$

The straight piece 5 is described by the straight line:

$$z(r)=z_{asph}(r_{fres\_begin}) \qquad \text{if } r_{fres\_end}<r<r_{circle\_begin}$$

The edge region is described by a circle function with the radius R = 0.165 mm:

$$Z_{circle}=Z_{mpoint}\sqrt{R^2-(r-\chi_{point})^2} \qquad \text{if } r_{Pmax}<r<r_{max}$$

with z_{mpoint} = z coordinate of the midpoint of the edge circle,

x_{mpoint} = r coordinate of the midpoint of the edge circle. r_{max} is the maximum distance from the axis or the half diameter. With the exception of r_{rfres_begin}, the r coordinates of the edge circle are equal in the case of all mold inserts.

In a preferred way, the zones with the differences in path length of the lens area 3 are located in the region of the deviation of the asphere from the spherical curve. The refractive component is formed by the central lens area 2, which in a preferred way has the spherical lens shape.

For forming a monofocal lens, the central lens area 2 and the annular lens area 3 are shaped in such a way that they have exactly the same focus and a common image is produced in all the zones of the optical lens part 1. The differences in the optical path length of the optical paths in adjacent zones are in this case adapted exactly to an integral multiple of an average wavelength of the visible spectrum, in particular to approximately 550 mm (design wavelength). The lens therefore produces a perfect image into the edge region. The depth of the concentric sawtooth zones is reduced here from zone to zone by 0.3 μm.

For forming a bifocal lens, an additional diffractive fine structure is provided on the optical lens part 1. This fine structure is preferably formed as a diffractive Fresnel pattern and has the form of annular fine structure elements 7 in sawtooth shape (figure 2). Figure 2 shows the essentially spherical profile of the section curve of the central lens area, forming the refractive component 2, on one side. Starting from a refractive base curve 8, with an essentially spherical section curve profile, the diffractive annular sawtooth zones have tooth depths from 1.5 μm to 2.8 μm. The difference in path length between adjacent zones may be a fraction, for example 0.4 or 0.6, of the design wavelength. The additional diffractive fine structure pattern is preferably provided in the central lens area, forming the refractive component. It may, however, also extend over the annular lens area 3 and overlap the zones located in this area. As figure 2 shows, the additional diffractive fine structure elements 7, starting from the refractive base curve 8, are formed into the surface of the lens body, in particular in the central area.

[List of designations]

1	optical lens part
2	central lens area
3	annular lens area
4	peripheral edge
5	straight piece
6	optical axis
7	additional diffractive fine structure elements
8	refractive base curve

[Patent claims]

1. An intraocular lens with an optical lens part, which has a central lens area and at least one further annular lens area surrounding said central lens area, characterized in that the central lens area (2) and the at least one annular lens area (3) form at least one common focus, and in that the annular lens area (3) has concentric annular zones, in which the difference in path length of the optical path between adjacent zones is an integral multiple of n = 2 or more of the design wavelength.

2. The intraocular lens as claimed in claim 1, characterized in that the difference in path length is set by the refractive index or the material and/or the geometry of the respective zone.

3. The intraocular lens as claimed in claim 1 or 2, characterized in that the annular zones are formed in a sawtooth-like manner.

4. The intraocular lens as claimed in one of claims 1 to 3, characterized in that the annular zones are provided on the front side and/or rear side of the lens body (1).

5. The intraocular lens as claimed in one of claims 1 to 4, characterized in that a refractive component (2) is formed in the central lens area (2).

6. The intraocular lens as claimed in one of claims 1 to 5, characterized in that the optical lens part has an aspherical curvature profile in the meridian section.

7. The intraocular lens as claimed in one of claims 1 to 6, characterized in that the annular area (3) with the concentric zones having the different path lengths is arranged in the lens part in which the aspherical curvature profile has an effect.

8. The intraocular lens as claimed in one of claims 1 to 7, characterized in that the annular lens area (3) has a width of approximately 0.8 mm to 0.9 mm, in particular 0.835 mm.

9. The intraocular lens as claimed in one of claims 1 to 8, characterized in that the central lens area (2) has a diameter of approximately 4 mm.

10. The intraocular lens as claimed in one of claims 1 to 9, characterized in that the outer lens edge (4) has an approximately semicircular cross section.

11. The intraocular lens as claimed in one of claims 1 to 10, characterized in that the central lens area (2) has a smooth surface.

12. The intraocular lens as claimed in one of claims 1 to 10, characterized in that, for forming a bifocal lens, additional diffractive zones (7) are provided on the optical lens part.

13. The intraocular lens as claimed in claim 12, characterized in that the additional diffractive zones (7) are provided on the central central lens area, forming the refractive component (2).

14. The intraocular lens as claimed in one of claims 1 to 13, characterized in that the difference in path length between the adjacent diffractive zones (7) is a fraction of the design wavelength.

15. The intraocular lens as claimed in one of claims 1 to 14, characterized in that the difference in path length between the adjacent diffractive zones (7) is 0.4 or 0.6 of the design wavelength.

16. The intraocular lens as claimed in one of claims 1 to 15, characterized in that the design wavelength lies in the green spectral range of visible light.

[Abstract]

An intraocular lens with an optical lens part, which has a central lens area 2 and at least one further annular lens area 3 surrounding said central lens area, the central lens area 2 and the at least one annular lens area 3 forming at least one common focus and the annular lens area 3 having concentric annular zones, in which the difference in pathlength between adjacent zones is an integral multiple of n = 2 or more of the design wavelength.

(Figure 1)

Fig. 1

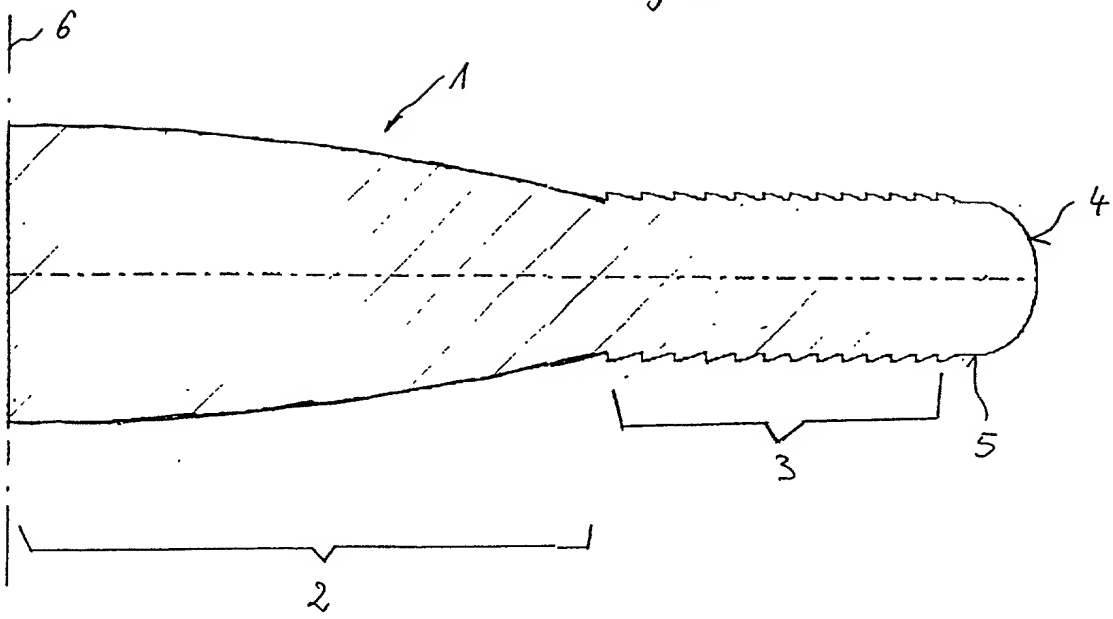
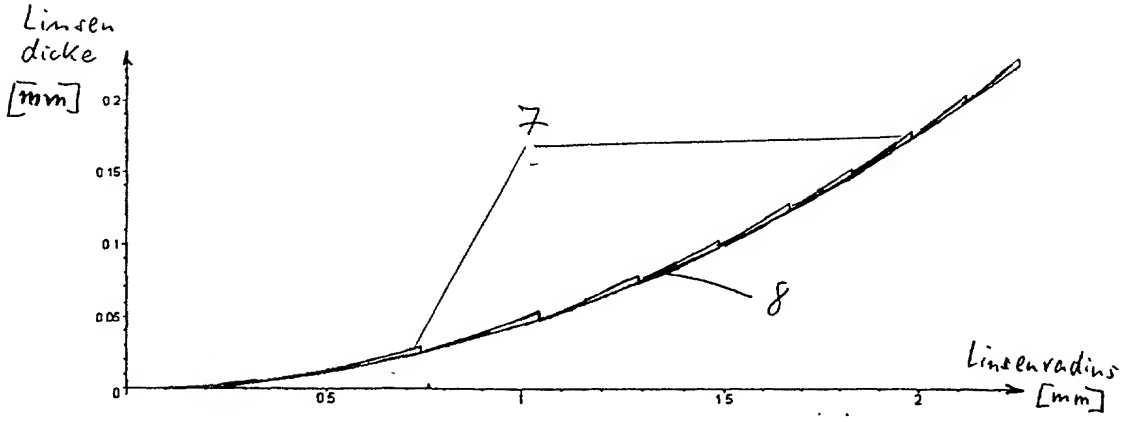

6
1
4
3
5
2

Fig. 2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0.1
0.05
0
7
8
0.5
1
1.5
2
Linsenradius [mm]

UNITED STATES OF AMERICA COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION	OFGS FILE NO. P/4074-4

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

INTRAOCULAR LENS

the specification of which is attached hereto, unless the following box is checked:

☒ was filed on December 10, 2001 as United States patent Application Number or PCT International patent application number 10/009,409 and was amended on _____ (if any).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate or United States provisional application(s) listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign or Provisional Application(s)

COUNTRY	APPLICATION NUMBER	DATE OF FILING *(day, month, year)*	PRIORITY CLAIMED UNDER 35 U.S.C. 119
Germany	199 26 512.7	10 June 1999	YES X NO ___
			YES ___ NO ___
			YES ___ NO ___

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

UNITED STATES APPLICATION NUMBER	DATE OF FILING *(day, month, year)*	STATUS *(patented, pending, abandoned)*

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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